THIN INTEGRATED CIRCUIT PACKAGE HAVING AN OPTICALLY TRANSPARENT WINDOW

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FIELD OF THE INVENTION

The present invention relates generally to integrated circuit packaging, and more specifically, to a thin integrated circuit package having an optically transparent window.

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BACKGROUND OF THE INVENTION

Optical integrated circuits are increasing in use to provide imaging, coupling and other optical functions for devices such as digital cameras, video cellular telephones, and other devices.

Digital cameras and cellular telephones are being fabricated in increasingly smaller and thinner packages, increasing market pressure on the semiconductor and subassembly manufacturers to supply thinner and smaller integrated circuit packages.

Optical integrated circuits are necessarily manufactured with a transparent cover that provides access to the optical functions on the integrated circuit die, while protecting the die from contamination and damage. Typically, the transparent

cover is incorporated within a molded covering a lead frame carrier, yielding a thick industry-standard package.

Therefore, it would be desirable to provide a thin integrated circuit package incorporating an optically transparent window.

SUMMARY OF THE INVENTION

The objective of providing a thin integrated circuit having an optically transparent window is accomplished in an integrated circuit assembly and a method for manufacturing an integrated circuit assembly.

An integrated circuit die is mounted on a tape having metal conductors on its surface and electrical interconnects disposed on a side opposite the die. The interconnects may be solder balls or other suitable electrical mounting interconnects. The die is surrounded by a thin supporting structure to which the tape is mounted. A glass cover is mounted over the die, to either the supporting structure or to the top of the die.

The present invention is best understood by reference to the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 depicts a cross section of an integrated circuit package in accordance with an embodiment of the present invention.

Figure 2 depicts a cross section of an integrated circuit package in accordance with an alternative embodiment of the present invention.

DETAILED DESCRIPTION

Referring to Figure 1, in integrated circuit package 10 in accordance with an embodiment of the present invention is depicted. Integrated circuit package 10, is a thin optical integrated circuit package, suitable for use in digital cameras, video cellular telephones and other devices where thickness of integrated circuits within the devices is critical.

A die 11 is mounted within an aperture in a support structure 17, which is bonded by an adhesive 14 to a flexible plastic tape 12 having metal conductors 13 disposed thereon. The use of tape 12, which is generally a polyimide tape having an etched copper conductive pattern on a top side, provides a very thin package for the integrated circuit. The tape-die assembly is supported by a support structure 17, which may be a very thin stamped metal sheet, a B-staged epoxy film, or other material suitable for providing stiffness to integrated circuit package 10. The combination of tape 12 and support structure 17

eliminate the need for the substrate typically used in prior-art optical integrated circuits, reducing the thickness of the optical integrated circuit substantially.

A transparent cover 18 is mounted over the optically active surface of die 11 by bonding transparent cover 18 to the top surface of support structure 17 using an adhesive 19. The electrical interface to die 11 is provided by a plurality of solder balls forming a ball grid array on the bottom side of tape 12.

In general, an optical integrated circuit package having a thickness less than 0.05 inches may be achieved using the above-described method and assembly. With a transparent glass cover of 10 mils thick, glass adhesive 2 mils thick, a support structure 20 mils thick and 4 mil tape, a total package thickness of 36 mils is achieved. Depending on stiffness requirements and the type of support structure 17 material used, the thickness of support structure may be reduced until the bottom of transparent cover almost contacts the top surface of die 11, further reducing the thickness of integrated circuit package 10.

Referring now to Figure 2, an optical integrated circuit package 20, in accordance with an alternative embodiment of the invention is depicted. In the alternative embodiment, transparent cover 18A is bonded directly to die 11, using an

optically transparent adhesive layer 19A. (In general, it is desirable that adhesive layer 19A provide an optical match between transparent cover 18A and die 11 and such adhesives are commonly available having a variety of refractive indices.) Alternatively, if the entire top surface of die is not optically active, a non-transparent adhesive may be used to bond the edges of die 11 to transparent cover 18A.

As described above for the embodiment of Figure 1, Die 11 is mounted within an aperture in a support structure 17, which is bonded by an adhesive 14 to a flexible plastic tape 12 having metal conductors 13 disposed thereon. The electrical interface to die 11 is provided by a plurality of solder balls forming a ball grid array on the bottom side of tape 12.

After die 11 and support structure 17 are applied to tape 12, and after transparent cover 18A is mounted to die 11 (transparent cover 18A may be mounted to die 11 just after singulation of die 11 and prior to bonding to tape 12), an encapsulant is applied between the die-cover assembly and the aperture walls in support structure 17, to fill the void between die-cover assembly and support structure 17. The above encapsulation yields an integrated circuit package 17, wherein the total package thickness is determined by the transparent cover 18A thickness, die 11 thickness and tape 12 thickness. The top surface of transparent cover 18A may be made conformal with

the top surface of support structure 17, and the thickness of support structure 17 may be only that thickness required to match the top surface of transparent cover 18A.

In general, an optical integrated circuit package having a thickness less than 0.03 inches may be achieved using the above-described method and assembly. With a transparent glass cover of 10 mils thick, glass adhesive 2 mils thick, die thickness of 11 mils, die adhesive 1.5 mils thick and 4 mil thick tape, a total package thickness of 26.5 mils is achieved.

This disclosure provides exemplary embodiments of the present invention. The scope of the present invention is not limited by these exemplary embodiments. Numerous variations, whether explicitly provided for by the specification or implied by the specification, such as variations in structure, dimension, type of material and manufacturing process may be implemented by one of skill in the art in view of this disclosure.